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Research Note
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Estimating Singleleaf Pinyon and Utah Juniper Volumes for Several Utilization Standards

**David C. Chojnacky
Caroline K. Wraith**[1]

ABSTRACT

Volume ratio tables have been developed to convert singleleaf pinyon and Utah juniper volumes from a 1.5-inch minimum branch diameter to other utilization standards. Examples are presented on use of volume ratios for determining outside-bark and inside-bark cubic-foot volume for 1- to 6-inch minimum branch diameter standards.

KEYWORDS: *Pinus monophylla, Juniperus osteosperma*

Ratio equations were developed to estimate pinyon and juniper volume for several utilization standards. Results were presented in equation form in the Western Journal of Applied Forestry (Chojnacky 1987). Because many forestry practitioners prefer volume results in table form, the volume ratio equations are tabulated in this paper.

Tables 1 and 2 give volume ratios for determining outside-bark and inside-bark cubic-foot volume for minimum branch diameter **(mbd)** standards from 1 to 6 inches. The volume ratios are designed to reduce volume predictions from equations that yield outside-bark (ob) volume of all stem and branch wood larger than 1.5 inches (fig. 1).

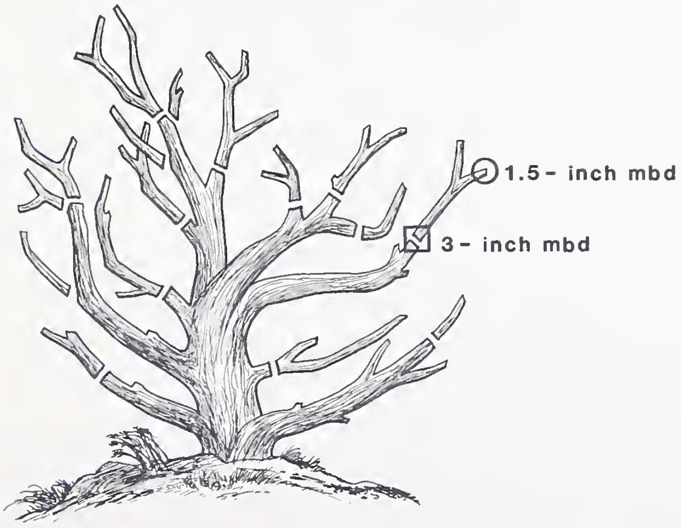

Figure 1—Comparison between 1.5-inch and 3-inch minimum branch diameter (mbd).

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[1] Research forester and forestry technician at Intermountain Research Station's Forestry Sciences Laboratory, Ogden, UT.

PINYON TABLE

Table 1—Pinyon volume ratios for determining outside-bark and inside-bark cubic-foot volume to different utilization standards

DSH	Basal stems	Minimum branch diameter (inches)									
		2	3	4	5	6	1	2	3	4	5
Inches		*Outside bark*					*Inside bark*				
4	Single	0.87	0.73				0.74	0.60	0.49		
	Multiple	.77	.53				.64	.45	.30		
6	Single	.88	.75	0.65	0.56		.76	.64	.54	0.46	0.38
	Multiple	.80	.61	.46	.33		.70	.54	.40	.29	.19
8	Single	.89	.77	.67	.59	0.51	.78	.67	.58	.50	.43
	Multiple	.83	.66	.52	.41	.31	.73	.59	.47	.37	.27
10	Single	.89	.78	.69	.61	.53	.79	.69	.60	.53	.46
	Multiple	.84	.69	.57	.47	.38	.75	.62	.51	.42	.34
12	Single	.90	.79	.70	.62	.55	.80	.70	.62	.55	.48
	Multiple	.86	.71	.60	.51	.43	.77	.65	.55	.46	.38
14	Single	.90	.79	.71	.63	.56	.81	.71	.63	.57	.50
	Multiple	.87	.73	.63	.54	.46	.78	.67	.58	.49	.42
16	Single	.90	.80	.71	.64	.58	.82	.72	.65	.58	.52
	Multiple	.87	.75	.65	.57	.49	.79	.69	.60	.52	.45
18	Single	.91	.80	.72	.65	.59	.82	.73	.66	.59	.54
	Multiple	.88	.76	.67	.59	.52	.80	.70	.62	.54	.47
20	Single	.91	.81	.73	.66	.60	.83	.74	.67	.60	.55
	Multiple	.88	.77	.68	.61	.54	.81	.71	.63	.56	.50
22	Single	.91	.81	.73	.67	.60	.83	.74	.67	.61	.56
	Multiple	.89	.78	.70	.62	.56	.82	.72	.65	.58	.51
24	Single	.91	.81	.74	.67	.61	.83	.75	.68	.62	.57
	Multiple	.89	.79	.71	.64	.58	.83	.73	.66	.59	.53

$$\hat{VR}_{ob} = \begin{cases} 1 - [0.27612(\text{mbd} - 1.5)^{0.67360}/\text{DSH}^{0.21114}] & \text{for single-stem trees} \\ 1 - [0.66949(\text{mbd} - 1.5)^{0.62895}/\text{DSH}^{0.44205}] & \text{for multiple-stem trees} \end{cases}$$

$$\hat{VR}_{ib} = \begin{cases} 1 - [0.37567(\text{mbd})^{0.59369}/\text{DSH}^{0.25692}] & \text{for single-stem trees} \\ 1 - [0.61912(\text{mbd})^{0.61412}/\text{DSH}^{0.39859}] & \text{for multiple-stem trees} \end{cases}$$

where

VR_{ob} = outside bark volume ratio

VR_{ib} = inside bark volume ratio

mbd = minimum branch diameter (inches)

DSH = basal diameter at 6-inch stump height (inches).

JUNIPER TABLE

Table 2—Juniper volume ratios for determining outside-bark and inside-bark cubic-foot volume to different utilization standards

		Minimum branch diameter (inches)									
DSH	**Basal stems**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**
Inches		*Outside bark*					*Inside bark*				
4	Single	0.83	0.66				0.68	0.53	0.42		
	Multiple	.71	.44				.59	.40	.25		
6	Single	.86	.71	0.59	0.49		.72	.58	.48	0.39	0.31
	Multiple	.76	.54	.37	.24		.64	.47	.34	.22	.12
8	Single	.87	.74	.64	.55	0.46	.74	.61	.52	.43	.3
	Multiple	.79	.59	.45	.33	.22	.67	.51	.39	.29	.19
10	Single	.88	.76	.67	.58	.51	.75	.64	.55	.47	.40
	Multiple	.81	.63	.50	.40	.30	.69	.55	.43	.33	.25
12	Single	.89	.78	.69	.61	.54	.76	.65	.57	.49	.43
	Multiple	.82	.66	.54	.44	.35	.71	.57	.46	.37	.29
14	Single	.90	.79	.71	.63	.57	.77	.67	.59	.51	.45
	Multiple	.84	.69	.58	.48	.40	.72	.59	.49	.40	.32
16	Single	.90	.80	.72	.65	.59	.78	.68	.60	.53	.47
	Multiple	.85	.71	.60	.51	.43	.73	.61	.51	.42	.35
18	Single	.91	.81	.73	.67	.61	.79	.69	.61	.55	.49
	Multiple	.85	.72	.62	.54	.46	.74	.62	.53	.44	.37
20	Single	.91	.82	.74	.68	.62	.80	.70	.62	.56	.50
	Multiple	.86	.73	.64	.56	.49	.75	.63	.54	.46	.39
22	Single	.91	.82	.75	.69	.64	.80	.71	.63	.57	.51
	Multiple	.87	.75	.65	.58	.51	.76	.64	.55	.48	.41
24	Single	.92	.83	.76	.70	.65	.81	.71	.64	.58	.52
	Multiple	.87	.76	.67	.60	.53	.76	.65	.57	.49	.42

$$\hat{V}R_{ob} = \begin{cases} 1 - [0.44761\,(\text{mbd} - 1.5)^{0.65698} / \text{DSH}^{0.38835}] & \text{for single-stem trees} \\ 1 - [0.82565\,(\text{mbd} - 1.5)^{0.59404} / \text{DSH}^{0.45831}] & \text{for multiple-stem trees} \end{cases}$$

$$\hat{V}R_{ib} = \begin{cases} 1 - [0.46178\,(\text{mbd})^{0.55473} / \text{DSH}^{0.27152}] & \text{for single-stem trees} \\ 1 - [0.62671\,(\text{mbd})^{0.55423} / \text{DSH}^{0.30675}] & \text{for multiple-stem trees} \end{cases}$$

where

VR_{ob} = outside bark volume ratio
VR_{ib} = inside bark volume ratio
mbd = minimum branch diameter (inches)
DSH = basal diameter at 6-inch stump height (inches).

Multiplying predicted volume times a volume ratio for a specified **mbd** yields volume to the specified **mbd**. This technique can be applied to the pinyon and juniper volume equations given by Chojnacky (1985) for the central Rocky Mountain States.

METHODS

Singleleaf pinyon (*Pinus monophylla* Torr. & Frém.) and Utah juniper (*Juniperus osteosperma* [Torr.] Little) trees were felled at 61 locations throughout the Great Basin on lands administered by the U.S. Department of the Interior, Bureau of Land Management (fig. 2).

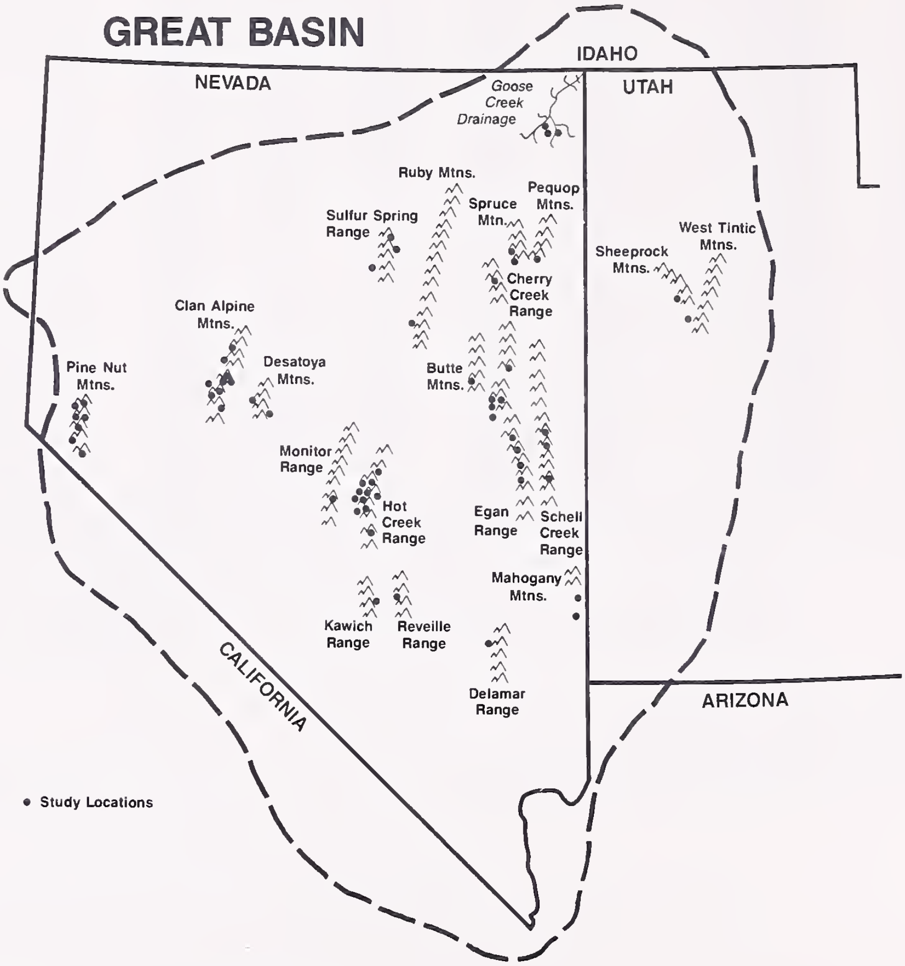

Figure 2—Map of 61 study locations.

Sample trees (having at least one basal stem ⩾ 3 inches) were measured for basal diameter at ground line near the root collar (DRC) and above ground line at 6-inch stump height (DSH). For multiple-stem trees that forked at or below either measurement point, an equivalent diameter (ED) was computed:

$$\mathrm{ED} = \sqrt{\sum_{i=1}^{n} D_i^2}$$

where

D_i = diameter of each stem larger than 1.5 inches

n = number of stems larger than 1.5 inches.

Wood volume was determined by using Newton's log formula (Husch and others 1982, p. 101) to compute cubic-foot volume for each tree cut into segments. Volumes for **mbd** ranging from 1 to 6 inches were computed for each tree. Nonlinear regression was used to model the data into volume ratio equations.

DIAMETER CONVERSIONS

Because previous pinyon and juniper inventories measured basal diameter at DRC, diameter conversion equations were developed to convert DRC to DSH for both pinyon and juniper (Chojnacky 1987):

Pinyon

$$DSH = -0.03 + (0.9826 \cdot DRC) - (0.20 \cdot STEM) \qquad (1)$$

Juniper

$$DSH = -0.77 + (0.9603 \cdot DRC) + (0.22 \cdot STEM) \qquad (2)$$

where

DRC = diameter at ground line (inches)
DSH = diameter at 6-inch stump height (inches)
STEM = 1 if single-stem tree, 0 otherwise.

These equations can therefore be used to apply volume ratio results to trees measured at DRC, as well as to trees measured at DSH.

APPLICATION OF VOLUME EQUATIONS

Examples of volume ratio application are illustrated for a single-stem 14-foot pinyon with a 15.5-inch DRC, and a multiple-stem 12-foot juniper with a 13.3-inch DRC. Volume equations for the examples are taken from Chojnacky (1985). The diameter conversion equation for each species is illustrated in step 1.

A: **Single-stem pinyon** (14 feet tall with a 15.5-inch DRC):

Step 1. **Diameter conversion** (only needed if appropriate diameter missing)
If DRC = 15.5
Then DSH = 15.0 (from eq. 1)

Step 2. **Volume ratio outside bark for 3-inch mbd (ob)**
If DSH = 15.0 and mbd = 3
Then $VR_{ob} = 0.80$ (from table 1)

Step 3. **Volume outside bark for 1.5-inch mbd (ob)**
If DRC = 15.5 and height = 14
Then $V = 8.76$ ft^3 (from table 13 in Chojnacky 1985)

Step 4. **Volume outside bark for 3-inch mbd (ob)**
Therefore, $(VR_{ob})(V) = (0.80)(8.76) = 7.01$ ft^3

B: **Multiple-stem juniper** (12 feet tall with a 13.3-inch DRC):

Step 1. **Diameter conversion**
If DRC = 13.3
Then DSH = 12.0 (from eq. 2)

Step 2. **Volume inside bark for 3-inch mbd (ib)**
If DSH = 12.0 and mbd = 3
Then $VR_{ib} = 0.46$ (from table 2)

Step 3. **Volume outside bark for 1.5-inch mbd (ob)**
If DRC = 13.3 and height = 12
Then $V = 3.98$ ft^3 (from table 6 in Chojnacky 1985)

Step 4. **Volume inside bark for 3-inch mbd (ib)**
Therefore, $(VR_{ib})(V) = (0.46)(3.98) = 1.83$ ft^3

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Intermountain Research Station
324 25th Street
Ogden, UT 84401